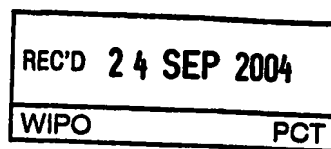




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Antikollisjonssystem

The present invention relates to a system for controlling the movement of objects in an automated system comprising independent transporting means for moving a number of objects relative to each other, and a method for avoiding collisions between the objects, and the use of such a system.

In automated or remote controlled systems comprising a number of objects moving partially independent of each other there is always a danger of collisions between the objects. One example of a system as described above is a system including automatic or remote operated machines involved in the operation of a drilling rig. A drilling rig comprises of several different machines. The machines are often specially developed to fit the layout on the rig and the strategy for operation, and may be moved in the system according to their purpose.

The target operation of a drilling rig is to drill wells on the seabed. This is, very simplified, done by rotating a drill string, with a drill bit in the lower end, and lowering it into the seabed. The drill string consists of several threaded pipes that are connected together. The pipes are made up/broke out in order to prolong or shorten the drill string. Consequently the main operation of a drilling rig is to drill, move pipes between horizontal and vertical positions and well centre, where the drill string is rotated, and make up/break out pipes when connecting/disconnecting pipes from the drill string. This represents a complex system as the different parts may have different weights, size, direction and velocity, and may in addition be regarded as part of the operation. Many of the objects may have complex geometries, making it even harder to predict the exact room they occupy in the system at all times. During complex operations there is a danger that the operator loses the overview of the situation, increasing the chances of collision. A collision may occur if the operator makes simple mistakes such as a misinterpretation of position data, the orientation of an object or if the object has shifted slightly relative to its registered location.

A solution to this would be to slow the operation down so as to maintain an overview of the system, or to use large safety margins which also reduces the speed and efficiency of the system, especially when operations are performed in areas with limited space, such as drill rigs at sea.

Thus it is an object of this invention to provide a system that allows several objects to move within a system without risking collisions or accidents,

providing an increased efficiency to the system when compared to the previously known systems. This object is obtained by a system as described in the accompanying independent claims.

The system according to the invention thus provides a simple and effective system which does not demand large calculation powers in operation, as it keeps track of geometrical objects being related to controllable position data for each object in the system, e.g. having simplified shapes which may give an extra tolerance in the stored position data and which are easy to visualise on a computer screen. In addition, a tolerance is provided around the objects and routines are established for relating a set of rules for the relative movements of the objects.

The management system related to this invention will be referred to below as a SmartZone Management System (SZMS).

The invention will be described below with reference to the accompanying drawings, illustrating the invention by way of example.

Figure 1: illustrates a pipe handling system suitable for implementation of the invention.

Figure 2: illustrates another pipe handling system suitable for implementation of the invention.

Figure 3: Principle drawing of two machines represented by boxes. The machines are travelling towards each other.

Figure 4: Principle drawing of two machines represented by boxes. Machine 1 is moving towards machine 2. Machine 2 is moving away from machine 1.

Figure 1 illustrates an example of a system on a drill rig, in which the system according to the invention may be used.

In horizontal to vertical pipe handling system the pipes (singles) 12 are usually stored horizontally and a single son pipe deck 11. A common configuration of machines 13, 15, 18 used to transport pipe between pipe deck (horizontally) and the drilling rig (vertically) 17 are a pipe crane 13 in combination with a tubular feeding machine 18 and an Eagle Light/HTV-Arm 15.

As is clear from this example the pipe handling system comprises a number of elements that may operate fairly independently of each other so that collisions may occur. Also, the different machines will take up different volumes of space, e.g.

when the crane picks up a pipe. Some of the parts of the system may also rotate such as the pipes 12, 14 being moved from a horizontal to a vertical position, and thus occupying a different space after than before the operation.

Figure 2 illustrates a vertical pipe handling system involving machines to move stands 21 (usually 2 or 3 made up of single pipes) vertically in the derrick between the vertical store (setback and fingerboard) 22, 24 and well center (WC) 26. It is usually a part of a drilling rig. This is a common configuration known as a "Vertical Pipehandling Two-Arm Syncro system" (VPH). This VPH system comprises of one bridge crane 23 mounted in the derrick and one lower guiding arm 25 mounted on drill floor. The drawing also shows a rough sketch for securing the stands 21 to the pipe already positioned in the well center 26. Thus this system moves the stands out of the vertical store onto the pipes in the well center.

As stated above the main purpose of this invention is to avoid collisions between machines that are members of the system. Referring also to figure 3 this is obtained by relating each part of the system to an imaginary 3-dimensional object 1, 2, 3 having a defined geometric shape corresponding to or exceeding the physical dimensions of the part in all directions. The imaginary object 1, 2, 3 is also assigned to position data corresponding to the physical position of the related machine part, so that it may control the movements of the object in a model of the real situation, wherein the model may incorporate all relevant information about fixed and moving objects in the real world. Thus machine M1 in figures 3 and 4 may thus represent a crane holding a horizontal pipe 2 moving toward the drill rig 3, M2.

Each geometric shape or box 1, 2, 3 may consist of several rectangles providing the approximate shape of the object, and may also rotate, e.g. correspond to a pipe being lifted from a horizontal to a vertical position. Thus the boxes are dynamic and reflect the machine's position and extent in the system. If boxes representing different machines are in conflict, (sharing room in the Cartesian coordinate system) a collision has occurred. All machines must relate to the same Cartesian coordinate system. The Cartesian coordinate system can be oriented with positive x-axis from well center toward V-door, positive y-axis from well center toward fingerboard and positive z-axis from drill floor and upward.

In addition, each machine M_1, M_2 is related to a stop distance (distance needed to come to a complete stop in a controlled manner) for each axis in the Cartesian co-ordinates system. The stop distances are the actual distances needed to stop the machine at the present speed and load in the given direction, and may depend on the weight or number of parts handled by each machine, as in the machine M_1 comprising two parts 1, 2. These stop distances are used in the system or method according to the invention to ramp down and stop the machines before collision occurs. A minimise function is implemented in the machine programmable logic controller (PLC) to make sure that the least of command value from operator (e.g. joystick) and allowed value (calculated in the system) is used for machine control.

Figure 3 shows a principle drawing of two machines represented by boxes. Box 1 and box 2 represent machine 1, box 3 represent machine 2. X_1 is the minimum distance between the two machines along the x-axis (at a given moment). X_2 is the distance the system uses to ramp down and stop machine 1 (derived from stop distance calculated in the machine PLC). X_4 is the distance the system uses to ramp down and stop machine 2. In figure 3, the two machines are travelling towards each other along the x-axis. If machine 1 or machine 2 is standing still or travelling in the opposite direction, X_2 and X_4 would be zero (respectively). X_5 is the safety distance between the two machines along the x-axis. As the machines are travelling towards each other, X_3 will decrease. When $X_3 = X_5$, the system starts to ramp down the machines. The machines will come to a complete stop with a distance of X_5 between them (along the x-axis). The same calculations and evaluations will be done for y-axis and z-axis.

In figure 4, machine 2 is moving away from machine 1 (along the x-axis) and machine 1 is moving towards machine 2. X_1 is the minimum distance between the two machines along the x-axis (at a given moment). X_2 is the distance the system uses to ramp down and stop machine 1 (derived from stop distance calculated in the machine PLC). X_5 is the safety distance between the two machines along the x-axis. X_6 is the distance the system uses to ramp up the speed of machine 1 (from 0 to full speed) along the x-axis. If both machines have come to a complete stop and machine 2 starts to move away from machine 1, the system ramps up the speed of machine 1 (follow function).

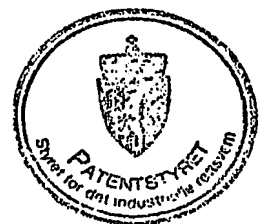
It is clear that the above mentioned objects 1, 2, 3 also may represent unmoveable structures such as the drill rig 17, so as to avoid collision between the machines and the rest of the installation.

5 All operators operating machines in the system according to the invention will have visualisation means available, e.g. related to a human machine interface (HMI). The HMI visualises if the machines have stopped (or are speed limited) due to action taken by the system. Through this interface it is possible to manually neglect/disregard machines from the management system (SZMS). Thus machines may be removed from the system, e.g. if an error has occurred, so that an operation may
10 continue.

Collision between machines and rigid structure etc may be handled by the present invention as an additional feature. The system is not only handling machine specific collision scenarios related to machine position, but also scenarios related to handling of pipe etc (e.g. do not hoist if both elevator and roughneck clamp is locked on pipe). Exceptions from zone management control are also handled by the present
15 invention (e.g. one machine allowed to disregard another machine presence in an area due to situations that frequently occur, and are supposed to occur, in normal operation).

The dynamic boxes have chosen geometric shape and chosen dimensions representing each machine. The control system according to the present invention
20 makes sure that there is a safety distance (but not much more) between the boxes (machines). A machine can follow another machine as long as the distance between them are greater than the safety distance.

The system and method according to the invention may be made using any available software and hardware tools, a person known in the art being able to choose
25 the system most suitable to each situation, for example depending on other already available equipment on the site. Although the system as described is based on knowledge of the positions of the moveable objects the system may also incorporate sensors giving feedback to the system about the whereabouts and orientation of each object, so as to provide an extra security against collisions due to erroneous or
30 unregistered shifts in the positions. Alternatively the system may of course be monitored visually in addition to showing the imaginary objects on a screen, so that an operator may obtain an additional control of the situation.



C l a i m s

1. System for controlling the movements of objects in an automatically remote operated system comprising independent transport means for moving a number of objects relative to each other, the system being provided with means for controlling the position and velocity of the objects relative to each other, wherein each object is related to a defined geometric shape related to the object positions having dimensions corresponding to or exceeding the physical dimensions of the object in all directions, and also defining a critical allowed distance between the defined geometric shapes.
2. System according to claim 1, wherein the dimensions of the geometric shape correspond to the size of the object.
3. System according to claim 1, wherein said critical distance is dependent on the relative movement between the objects.
4. System according to claim 1, wherein the critical distance between two geometric shapes moving toward each other corresponds to the braking distance for each corresponding object plus a chosen additional distance.
5. System according to claim 1, wherein the objects and corresponding geometric shapes are adapted to be rotatable.
6. System according to claim 1, wherein the geometric shape is rectangular.
7. Method for avoiding collisions between automatically controlled or remote operated objects having variable positions and movements relative to each other said positions and movements being controlled by a control system, comprising assigning a geometric shape to each object, said geometric shape corresponding to or exceeding the dimensions of the corresponding object, the geometric shape thus occupying a space corresponding to or exceeding the space occupied by the object, and defining a critical minimum distance between said geometric shapes.

8. Method according to claim 7, wherein the dimensions of the geometric shape correspond to the size of the object.
- 5 9. Method according to claim 7, wherein a critical distance is dependent on the relative movement between the objects.
10. Method according to claim 7, wherein the critical distance between two geometric shapes moving toward each other corresponds to the braking distance for each corresponding object plus a chosen additional distance.
- 10 11. Method according to claim 7, wherein the objects and corresponding geometric shapes are adapted to be rotatable.
- 15 12. Method according to claim 7, wherein the geometric shapes are rectangular.
13. Use of a system according to claim 1 on offshore installations, especially for handling pipes in drilling operations, wherein said objects correspond to means for storing, moving and/or installing equipment in the installations.
- 20 14. Use according to claim 13, wherein the installation is a drilling rig and the system is used for storing, moving and installing pipes on a drilling rig.



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Abstract

This invention relates to a system for controlling the movement of objects in an automated or remote operated system, as well as a related method and use of the system comprising independent transporting means for moving a number of objects relative to each other, the system being provided with means for controlling the position and velocity of the objects relative to each other. Each object is related to a defined geometric shape related to the object positions having dimensions corresponding to or exceeding the physical dimensions of the object in all directions, and also defining a critical allowed distance between the defined geometric shapes.

Figure 3



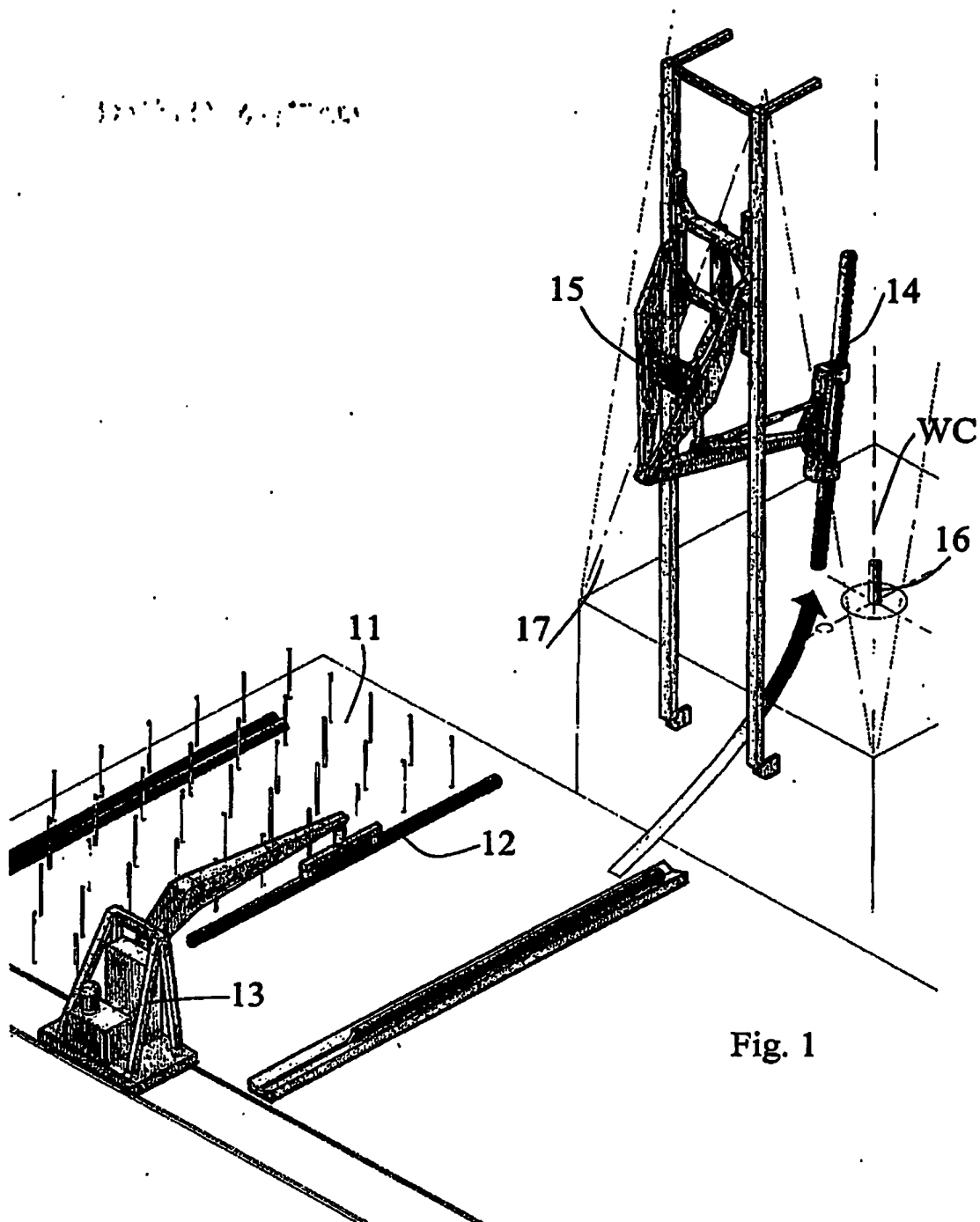


Fig. 1



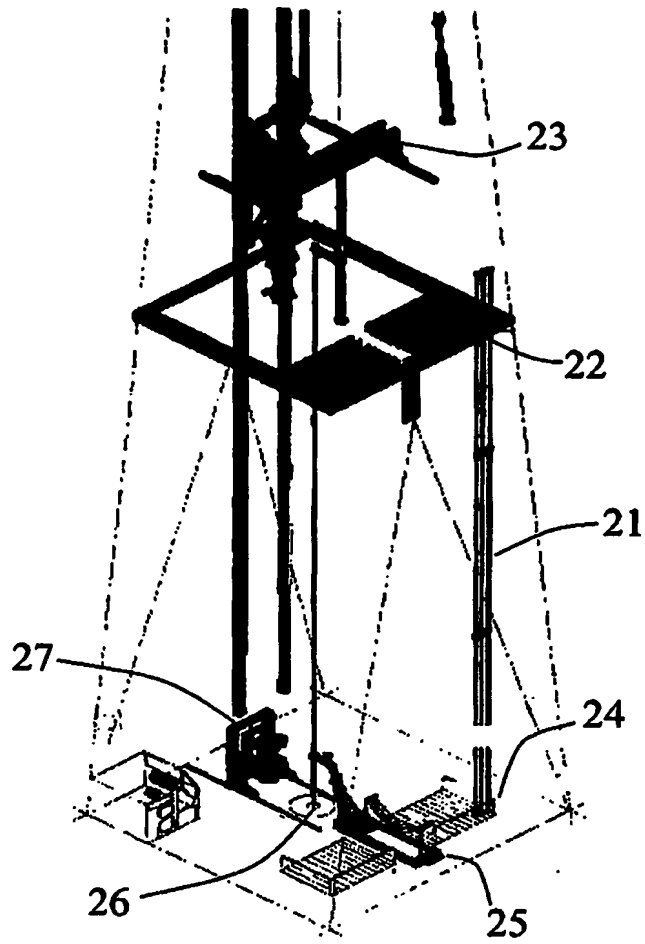


Fig. 2



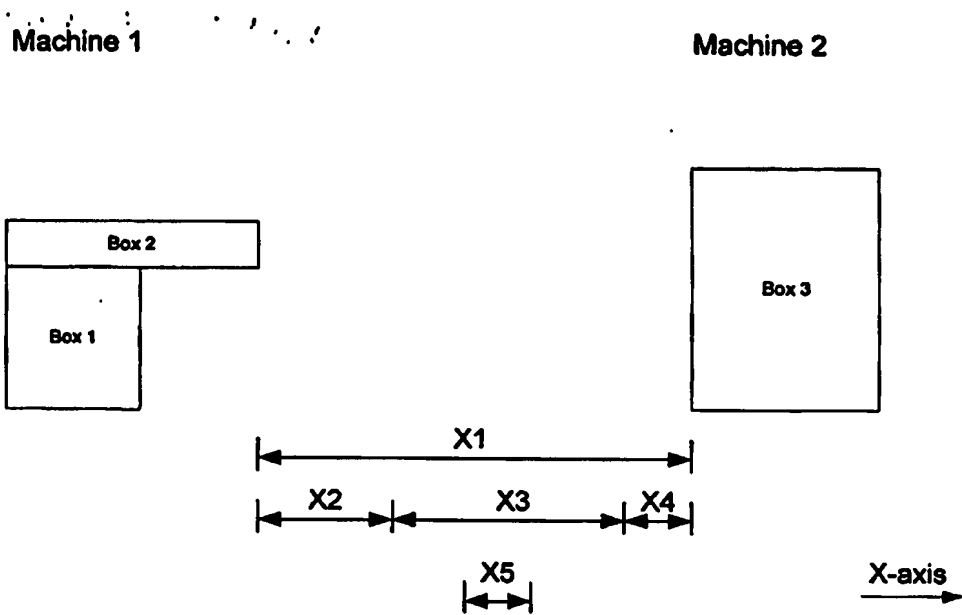


Figure 3

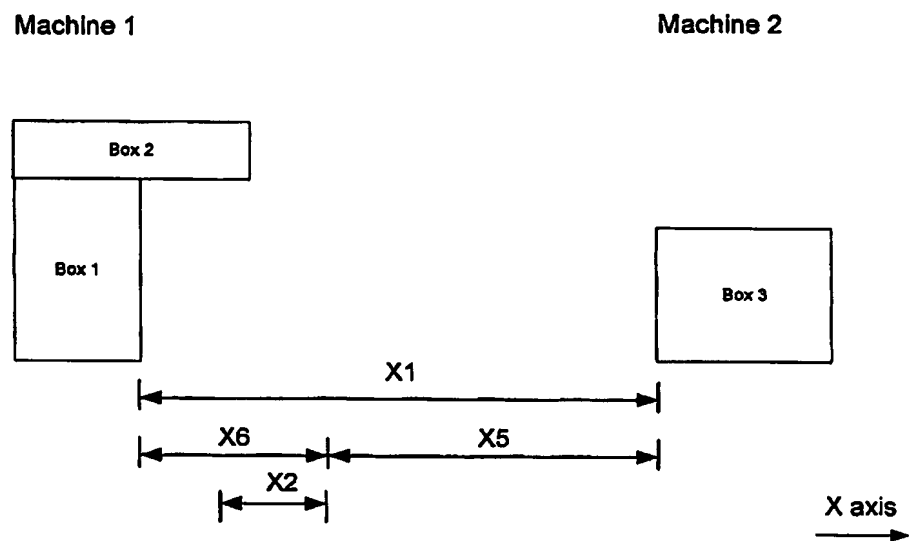


Figure 4

